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**(54) ALUMINUM ALLOY-MADE HEAT EXCHANGER AND ITS MANUFACTURE**

**(57)Abstract:**

**PURPOSE:** To obtain an aluminum alloy-made heat exchanger having excellent joining strength between a tube material and a fin and corrosion resistance by thermal-spraying the specific alloy containing Bi as a brazing filler metal on the surface of the tube material and applying a flux brazing or an atmospheric brazing after assembling the bear fins of a specific aluminum alloy.

**CONSTITUTION:** After thermal-spraying Zn on the surface, the aluminum alloy-made bear fins are joined to the aluminum alloy-made tube material having the film thermal-spraying the brazing filler metal by the flux brazing or the atmospheric

brazing. The alloy composition of the brazing filler metal is the Al alloy composed of 6–13wt% Si, 0.1–0.5% Bi and the balance Al with inevitable impurities. Further, the alloy composition of the bear fin is the Al alloy composed of 0.5–5wt% Mn and the balance Al with inevitable impurities or the Al alloy composed of 0.5–5wt.% Mn, 0.5–8% Zn and the balance Al with inevitable impurities.

## CLAIMS

[Claim(s)]

[Claim 1] After carrying out thermal spraying of the Zn to the surface, to a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material Si:6 – 13wt% and Bi:0.1 – 0.5wt%, The remainder is an aluminum alloy which consists of aluminum and unescapable non-purity, An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 – 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 – 8wt% Mn:0.5 – 5wt%.

[Claim 2] To a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material to the surface. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material Si:6 – 13wt% and Zn:0.5 – 8wt%, Bi:0.1 – 0.5wt% and the remainder are the aluminum alloys which consist of aluminum and unescapable non-purity, An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 – 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 – 8wt% Mn:0.5 – 5wt%.

[Claim 3] After carrying out thermal spraying of the Zn to the surface of a tube which consists of aluminum or an aluminum alloy, Alloy composition carries out thermal spraying of the wax material which consists of an aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Bi:0.1 – 0.5wt% Si:6 – 13wt%, An aluminum alloy whose alloy composition is Mn:0.5 – 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux-] or brazed [ atmosphere-] after \*\*\*\*\* BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 – 8wt% Mn:0.5 – 5wt%.

[Claim 4] Alloy composition on the surface of a tube which consists of aluminum or an aluminum alloy Si:6 – 13wt%, The remainder carries out thermal spraying of the wax material which consists of an aluminum alloy which consists of aluminum and

unescapable non-purity Bi:0.1 – 0.5wt% Zn:0.5 – 8wt%, An aluminum alloy whose alloy composition is Mn:0.5 – 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux-] or brazed [ atmosphere-] after \*\*\*\*\* BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 – 8wt% Mn:0.5 – 5wt%.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

[Translation done.]

## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention is a thing about the aluminum alloy made heat exchanger manufactured by the flux brazing method or atmosphere brazing.

The aluminum alloy made heat exchanger of this invention is widely applied to the heat exchanger for car air conditioners, an industrial heat exchanger, etc.

[0002]

[Description of the Prior Art] The conventional aluminum alloy made heat exchanger to the tube material which consists of raise in basic wages material of aluminum (JISA1050, JIS A1100) or an aluminum alloy (aluminum-Mn) by which extrusion molding was carried out. Make aluminum-Mn alloy into a core material, use an aluminum-6 to 15%Si-0.5 to 3% Mg alloy, or an aluminum-7 to 15% Si alloy for wax material, and both are cold-rolled between heat from a clad sheet, It was considered as the brazing sheet, the fabrication of the fin material which consists of a tube which carried out Zn thermal spraying, and a brazing sheet was carried out, and the back with a group had joined between headers to the tube of an aluminum alloy, and between fins and a tube by the flux brazing method or atmosphere brazing with the jig.

[0003] However, since a fin is the brazing sheet in which the clad of the high aluminum-Si-Mg alloy or aluminum-Si-Mg-Zn alloy of hardness was carried out to the surface in this conventional method, In the rolling process, especially cold rolling process from an ingot clad sheet of a brazing sheet, wear of a reduction roll is intense, and. When processing a brazing sheet into the fin of a heat exchanger, the abrasion life of the louver cutter which carries out shearing of the louver formed in a fin is dramatically short, and the manufacturing cost of an aluminum alloy made heat exchanger becomes high.

[0004] The coat of the aluminum-Zn-Si alloy of a specific range is formed in the surface of the tube of aluminum or an aluminum alloy, the fin which does not have wax material is attached and the manufacturing method of the heat exchanger made of aluminum which carries out flux brazing is known (JP,H1-107961,A).

[0005] However, in this conventional technology, since the wettability of wax material and mobility were not enough, there was a problem that the intensity of junction ran short a little.

[0006]

[Problem(s) to be Solved by the Invention] This invention is made that the problem of the above-mentioned conventional technology should be canceled, and the purpose of this invention, The life of the reduction roll in the rolling process from the ingot clad sheet of a brazing sheet is developed, It is providing the aluminum alloy made heat exchanger which reduced the manufacturing cost of the aluminum alloy made heat exchanger, and was excellent in a tube material, the bonding strength of a fin, and corrosion resistance by developing the abrasion life of the louver cutter which carries out shearing of the louver formed in a fin.

[0007]

[Means for Solving the Problem and its Function] This invention persons do thermal spraying of the specific alloy containing Bi to the tube material surface as wax material, as a result of repeating research wholeheartedly that an aforementioned problem should be solved, It finds out that what is necessary is for the back with a group just to flux-braze or atmosphere braze a fin which consists of raise in basic wages material of a specific aluminum alloy, and came to complete this invention.

[0008] After this invention carries out thermal spraying of the Zn to (1) surface, to namely, a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material Si:6 – 13wt% and Bi:0.1 – 0.5wt%, The remainder is an aluminum alloy which consists of aluminum and unescapable non-purity, An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 – 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 – 8wt% Mn:0.5 – 5wt%.

[0009] (2) To a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material to the surface. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material Si:6 – 13wt% and Zn:0.5 – 8wt%, Bi:0.1 – 0.5wt% and the remainder are the aluminum alloys which consist of aluminum and unescapable non-purity, An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 – 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 – 8wt% Mn:0.5 – 5wt%.

[0010](3) After carrying out thermal spraying of the Zn to the surface of a tube which consists of aluminum or an aluminum alloy, Alloy composition carries out thermal spraying of the wax material which consists of an aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Bi:0.1 – 0.5wt% Si:6 – 13wt%, An aluminum alloy whose alloy composition is Mn:0.5 – 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux–] or brazed [ atmosphere–] after \*\*\*\*\* BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 – 8wt% Mn:0.5 – 5wt%.

[0011](4) On the surface of a tube which consists of aluminum or an aluminum alloy. Alloy composition Si:6 – 13wt% and Zn:0.5 – 8wt% and Bi:0.1 – 0.5wt%, The remainder carries out thermal spraying of the wax material which consists of an aluminum alloy which consists of aluminum and unescapable non-purity, An aluminum alloy whose alloy composition is Mn:0.5 – 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux–] or brazed [ atmosphere–] after \*\*\*\*\* BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 – 8wt% Mn:0.5 – 5wt%. It is considered as a gist.

[0012]In this invention, what is used as a tube material is not limited to these, although an aluminum alloy which added aluminum or Mn of JIS A1050 and JIS A1100 grade, etc. is mentioned. A tube is fabricated by an extrusion–molding method in aluminum or an aluminum alloy.

[0013]After this invention carries out thermal spraying of the Zn to the surface of a tube of extruded raise in basic wages material with a manufacturing method of a tube material, It is divided when carrying out thermal spraying of the wax material of an aluminum–Si–Zn–Bi alloy to a case where thermal spraying of the wax material of an aluminum–Si–Bi alloy is carried out, at once on the surface of a tube of (Claim 1, 3), and extruded raise in basic wages material (Claim 2, 4).

[0014]In order to carry out thermal spraying of the Zn to a tube, what is necessary is just to carry out thermal spraying immediately after extrusion of an extrusion flat tube of aluminum or an aluminum alloy, and preheating as thermal–spraying pretreatment is unnecessary. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient as a thermal spraying method. Thermal spraying of Zn adjusts the amount of thermal spraying so that metsuke amount may become 5 – 20 g/m<sup>2</sup>.

[0015] Since raise in basic wages material to which the clad of the wax material (hard aluminum-Si alloy) is not carried out is used for a fin material, wax material is made to cover with a spraying process on a tube in this invention. Wax material by which thermal spraying is carried out to the surface of a tube of aluminum or an aluminum alloy is an aluminum-Si-Bi alloy or an aluminum-Si-Bi-Zn alloy of a range specific as mentioned above, and an operation of each ingredient and the Reason for limitation of a blending ratio are as follows.

[0016]– Lower the melting point of SiAl, make mobility after melting good, and raise brazing nature. If it separates from 6wt% – 13wt% of a range, the melting point of aluminum-Si alloy will become high, and mobility after melting falls and brazing nature falls.

[0017]– Since the wettability of aluminum-Si alloy after Bi melting improves and the mobility of aluminum-Si-alloy wax material improves, brazing nature becomes good. 0. Since the wettability of wax material which consists of an aluminum-Si-alloy thermal spraying material, and mobility fall, it is not desirable less than [ 1wt% ]. Even if it adds exceeding 0.5wt%, the mobility of wax material and wettability which consist of an aluminum-Si-alloy thermal spraying material do not improve.

[0018]– Into Zn brazing heat cycle, it is spread on a surface of heat exchanger tubes, and form a zinc diffused layer very effective in pitting prevention of an aluminum alloy. 0. Since an excessive zinc diffused layer will be formed if a zinc diffused layer effective in corrosion prevention is not formed enough but adds exceeding 8wt%, and an anticorrosion life of a heat exchanger falls on the contrary, it is not desirable less than [ 5wt% ].

[0019] As a thermal spraying method of wax material to a tube (extrusion flattened tube), Although there is a two-way-type method which carries out thermal spraying of the Bi alloy to a tube extruded in pure Zn with a method of carrying out thermal spraying of the Bi alloy aluminum-8 to 13%Si-0.1 to 0.5% further after thermal spraying once to a tube extruded from an extrusion machine aluminum-8 to 13%Si-0.5 to 8%Zn-0.1 to 0.5%, All are effective.

[0020] Methods of carrying out thermal spraying of the wax material to BEAFIN may include a method of carrying out thermal spraying of the above-mentioned after alloy powder, and a method of carrying out thermal spraying of the wire of the above-mentioned alloy, and any may be sufficient. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient.

[0021] A fin used for this invention is the raise in basic wages material (nakedness material to which the clad of the wax material is not carried out) of aluminum-Mn alloy



## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention is a thing about the aluminum alloy made heat exchanger manufactured by the flux brazing method or atmosphere brazing. The aluminum alloy made heat exchanger of this invention is widely applied to the heat exchanger for car air conditioners, an industrial heat exchanger, etc.

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[0015] Since raise in basic wages material to which the clad of the wax material (hard aluminum-Si alloy) is not carried out is used for a fin material, wax material is made to cover with a spraying process on a tube in this invention. Wax material by which thermal spraying is carried out to the surface of a tube of aluminum or an aluminum alloy is an aluminum-Si-Bi alloy or an aluminum-Si-Bi-Zn alloy of a range specific as mentioned above, and an operation of each ingredient and the Reason for limitation of a blending ratio are as follows.

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[0019] As a thermal spraying method of wax material to a tube (extrusion flattened tube), Although there is a two-way-type method which carries out thermal spraying of the Bi alloy to a tube extruded in pure Zn with a method of carrying out thermal spraying of the Bi alloy aluminum-8 to 13%Si-0.1 to 0.5% further after thermal spraying once to a tube extruded from an extrusion machine aluminum-8 to 13%Si-0.5 to 8%Zn-0.1 to 0.5%, All are effective.

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[0021] A fin used for this invention is the raise in basic wages material (nakedness material to which the clad of the wax material is not carried out) of aluminum-Mn alloy

or an aluminum-Mn-Zn alloy. An operation of an ingredient of an aluminum alloy of BEAFIN and the Reason for limitation of a blending ratio are as follows.

[0022]- Mn hardness and intensity improve and modification of a fin at the time of brazing heating can be prevented. 0. Since intensity will go up too much and a fabricating operation of a fin will become difficult if modification of a fin at the time of brazing heating cannot be prevented but it adds exceeding 5wt%, it is not desirable less than [ 5wt% ].

[0023]- Corrosion potential of Zn fin is lowered and there is an operation which carries out cathodic protection of the tube. 0. In order to carry out cathodic protection of the tube, even if it cannot be considered as potential of sufficient \*\* but adds exceeding 8wt%, potential of \*\* does not improve, but self-corrosion of a fin becomes intense, and it is not desirable less than [ 5wt% ].

[0024]Since wax material is raise in basic wages material by which a clad is not carried out, a fin of this invention is soft, and a life of a cold rolling roll of a manufacturing process of a brazing sheet used as a fin material is extended substantially, and. Since a life of a louver cutter used for louver shearing of a brazing sheet used as a fin material is extended substantially, a manufacturing cost can be lowered substantially.

[0025]BEAFIN with a thickness of 0.1-0.3 mm manufactured by cold rolling etc., A tube material and BEAFIN by which it was fabricated by fin configuration which has a louver with a louver cutter, and wax material was covered with the above-mentioned spraying process using a jig After [ with a group ], By the flux brazing method or the atmosphere brazing method, between headers is joined to a fin, and between tubes and a tube, and it is completed as an aluminum alloy made heat exchanger.

[0026]Flux used by flux brazing will not be limited especially if usually used, but fluoride systems, such as chloride systems, such as NaCl and KCl,  $\text{KAlF}_4$ , and  $\text{K}_3\text{AlF}_6$ , are mentioned, for example.

[0027]The atmosphere brazing method in this invention is among inert atmospheres, such as nitrogen gas and argon gas, a range of cooking temperature is 590-610 \*\*, and the furnace pressure should just braze in the range of 0.1 - 760Torr.

[0028]The brazing temperature should just perform the flux brazing method and the atmosphere brazing method at 590-610 \*\*, wax material fuses in response to a brazing thermal excursion, a fillet is formed between a tube, between fins and a tube, and a header, and junction is completed. Chemical conversion and resin coating processing are performed if needed after that.

[0029]When carrying out thermal spraying of the wax material of an aluminum-Si-Bi alloy after carrying out thermal spraying of the Zn to the surface of a tube of extruded

raise in basic wages material, into temperature up of a brazing process, Zn sprayed layers fuse, are diffused in a raise in basic wages tube material, and form an effective Zn diffused layer in a tube surface on corrosion prevention. When carrying out thermal spraying of the wax material of an aluminum-Si-Zn-Bi alloy to the surface of a tube of extruded raise in basic wages material at once, Zn in wax material is spread in a raise in basic wages fin material in a temperature rise process, and an effective Zn layer is formed on corrosion prevention.

[0030]An aluminum alloy made heat exchanger of this invention is applicable to a heat exchanger of the Serpentine type, a parallel flow type, a DORON cup (lamination) type, and other various form.

[0031]Hereafter, although working example explains this invention in detail, it is not limited to these working example.

[0032]

[Example]

In the 200-400 \*\* tube (extrusion flattened tube) just behind the extrusion of working example 1 pure aluminium (aluminum:99.9wt%). 10 g/m<sup>2</sup> thermal spraying carried out the pure Zn wire (1.6mmphi) with the arc spraying method, and metsuke amount 50 g/m<sup>2</sup> thermal spraying carried out the aluminum containing alloy wire which consists of aluminum-11%Si-0.3%Bi immediately after [ the ] with the arc spraying method.

[0033]Louver processing was carried out and the BEAFIN (aluminum-1%Mn-1%Zn) raw material created separately was attached with an above-mentioned tube and jig. After spray coating, it dried and the flux which becomes the attached heat exchanger material from the potash salt of aluminum fluoride was inserted in the NOKOROKKU brazing furnace.

[0034]From ordinary temperature to 605 \*\*, temperature up of the brazing temperature pattern was carried out, and it was cooled after maintenance for 5 minutes. Into the temperature up of this brazing process, Zn sprayed layers fused, were diffused in the tube material (A1050), and formed the with the surface zinc concentration of 3%, and a diffusing depth of 120 micrometers zinc diffused layer. Compared with the tube core material (pure aluminum of A1050etc), the corrosion potential of this zinc diffused layer was \*\*, and breakthrough foods were not generated at all in 5000 h of neutral salt spray tests at a 0.4-mm thick tube material, but it was very effective in pitting prevention of a tube.

[0035]Melting was started at 590 \*\*, it is the brazing retention time for 605 \*\*x 5 minutes, the fillet of sufficient size was formed on intensity between tube fins and between tube headers, and the wax piece of the brazing part did not generate wax

material (aluminum-Si-Bi in a thermal spraying material), either.

[0036] Electric arc spraying of the pure Zn wire (1.6mmphi) was carried out to the 200-400 °C tube just behind the extrusion of working example 2 pure aluminium (aluminum:99.9wt%), and thermal spraying of the powder (particle size undershirt of 70 micrometers) of a Bi alloy was further carried out to it by high speed gas flame thermal spraying aluminum-11%Si-0.3% after that.

[0037] The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0038] Thermal spraying of the aluminum alloy wire (1.6mmphi) which becomes a 200-400 °C tube just behind the extrusion of working example 3 pure aluminium (aluminum:99.9wt%) from aluminum-11%Si-5%Zn-0.3%Bi was carried out by electric arc spraying.

[0039] The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0040] Thermal spraying of (the particle size undershirt of 70 micrometers) was carried out for the aluminum alloy powder which becomes a 200-400 °C tube just behind the extrusion of working example 4 pure aluminium (aluminum:99.9wt%) from a Bi alloy aluminum-11%Si-5%Zn-0.3% by high speed gas flame thermal spraying.

[0041] The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0042] Once having dried and preheating the tube material made from working example 5 aluminum alloy (extrusion flattened tube) with an arc and gas flame at 200-400 °C after water cooling, even if it performed above-mentioned working example 1-4, it checked that the completely same result was obtained.

[0043] The interval of regrinding by paper polish of a roll in the cold rolling process of each working example was extended several times, and it was admitted that the endurance of a roll was improving.

[0044] It was admitted that the endurance (hour of use until it discards) of the louver cutter in each working example was also extended several times.

[0045]

[Effect of the Invention] The aluminum alloy made heat exchanger of this invention has the following outstanding effects.

(1) Since Bi is contained in the wax material by which thermal spraying is carried out

on the surface of a tube material and the mobility of wax material and wettability are improved, fillet sufficient between tube fins and between tube headers is formed, and sufficient junction is made on intensity and pressure-proofing.

[0046](2) Diffuse Zn by which thermal spraying was carried out to BEAFIN, or Zn in wax material in a tube material by the thermal excursion in flux brazing or an atmosphere brazing process, and it forms the Zn diffused layer which has a preeminent effect in the corrosion-resistant improvement in a tube.

[0047](3) Since a fin is the soft raise in basic wages material of aluminum-Mn alloy or an aluminum-Mn-Zn alloy, wear of the reduction roll of the rolling process from an ingot, especially a cold rolling process is \*\*\*\*(ed) sharply, and an endurance life improves sharply, and. The endurance of the louver cutter at the time of louver processing of the heat-exchanger-fins material (0.1-0.3-mm thickness) which consists of brazing sheets can improve preeminently, and a manufacturing cost can be reduced.



[Translation done.]



**TECHNICAL FIELD**

[Industrial Application] This invention is a thing about the aluminum alloy made heat exchanger manufactured by the flux brazing method or atmosphere brazing. The aluminum alloy made heat exchanger of this invention is widely applied to the heat exchanger for car air conditioners, an industrial heat exchanger, etc.

[Translation done.]

**TECHNICAL FIELD**

[Industrial Application] This invention is a thing about the aluminum alloy made heat exchanger manufactured by the flux brazing method or atmosphere brazing. The aluminum alloy made heat exchanger of this invention is widely applied to the heat exchanger for car air conditioners, an industrial heat exchanger, etc.

[Translation done.]

## PRIOR ART

[Description of the Prior Art]The conventional aluminum alloy made heat exchanger to the tube material which consists of raise in basic wages material of aluminum (JISA1050, JIS A1100) or an aluminum alloy (aluminum-Mn) by which extrusion molding was carried out. Make aluminum-Mn alloy into a core material, use an aluminum-6 to 15%Si-0.5 to 3% Mg alloy, or an aluminum-7 to 15% Si alloy for wax material, and both are cold-rolled between heat from a clad sheet, It was considered as the brazing sheet, the fabrication of the fin material which consists of a tube which carried out Zn thermal spraying, and a brazing sheet was carried out, and the back with a group had joined between headers to the tube of an aluminum alloy, and between fins and a tube by the flux brazing method or atmosphere brazing with the jig. [0003]However, since a fin is the brazing sheet in which the clad of the high aluminum-Si-Mg alloy or aluminum-Si-Mg-Zn alloy of hardness was carried out to the surface in this conventional method, In the rolling process, especially cold rolling process from an ingot clad sheet of a brazing sheet, wear of a reduction roll is intense, and. When processing a brazing sheet into the fin of a heat exchanger, the abrasion life of the louver cutter which carries out shearing of the louver formed in a fin is dramatically short, and the manufacturing cost of an aluminum alloy made heat exchanger becomes high.

[0004]The coat of the aluminum-Zn-Si alloy of a specific range is formed in the surface of the tube of aluminum or an aluminum alloy, the fin which does not have wax material is attached and the manufacturing method of the heat exchanger made of aluminum which carries out flux brazing is known (JP,H1-107961,A).

[0005]However, in this conventional technology, since the wettability of wax material and mobility were not enough, there was a problem that the intensity of junction ran short a little.

[Translation done.]

## EFFECT OF THE INVENTION

[Effect of the Invention] The aluminum alloy made heat exchanger of this invention has the following outstanding effects.

(1) Since Bi is contained in the wax material by which thermal spraying is carried out on the surface of a tube material and the mobility of wax material and wettability are improved, fillet sufficient between tube fins and between tube headers is formed, and sufficient junction is made on intensity and pressure-proofing.

[0046](2) Diffuse Zn by which thermal spraying was carried out to BEAFIN, or Zn in wax material in a tube material by the thermal excursion in flux brazing or an atmosphere brazing process, and it forms the Zn diffused layer which has a preeminent effect in the corrosion-resistant improvement in a tube.

[0047](3) Since a fin is the soft raise in basic wages material of aluminum-Mn alloy or an aluminum-Mn-Zn alloy, wear of the reduction roll of the rolling process from an ingot, especially a cold rolling process is \*\*\*\*(ed) sharply, and an endurance life improves sharply, and. The endurance of the louver cutter at the time of louver processing of the heat-exchanger-fins material (0.1-0.3-mm thickness) which consists of brazing sheets can improve preeminently, and a manufacturing cost can be reduced.

[Translation done.]

**TECHNICAL PROBLEM**

[Problem(s) to be Solved by the Invention] This invention is made that the problem of the above-mentioned conventional technology should be canceled, and the purpose of this invention, The life of the reduction roll in the rolling process from the ingot clad sheet of a brazing sheet is developed, It is providing the aluminum alloy made heat exchanger which reduced the manufacturing cost of the aluminum alloy made heat exchanger, and was excellent in a tube material, the bonding strength of a fin, and corrosion resistance by developing the abrasion life of the louver cutter which carries out shearing of the louver formed in a fin.

[0007]

[Translation done.]

## OPERATION

[Means for Solving the Problem and its Function] This invention persons do thermal spraying of the specific alloy containing Bi to the tube material surface as wax material, as a result of repeating research wholeheartedly that an aforementioned problem should be solved, It finds out that what is necessary is for the back with a group just to flux-braze or atmosphere braze a fin which consists of raise in basic wages material of a specific aluminum alloy, and came to complete this invention.

[0008] After this invention carries out thermal spraying of the Zn to (1) surface, to namely, a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material is an aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Bi:0.1 – 0.5wt% Si 6 – 13wt%.

An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 – 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 – 8wt% Mn:0.5 – 5wt%.

[0009] (2) To a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material to the surface. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material Si:6 – 13wt% and Zn:0.5 – 8wt%, Bi:0.1 – 0.5wt% and the remainder are the aluminum alloys which consist of aluminum and unescapable non-purity, An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 – 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 – 8wt% Mn:0.5 – 5wt%.

[0010] (3) After carrying out thermal spraying of the Zn to the surface of a tube which consists of aluminum or an aluminum alloy, Alloy composition carries out thermal spraying of the wax material which consists of an aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Bi:0.1 – 0.5wt% Si:6 – 13wt%, An aluminum alloy whose alloy composition is Mn:0.5 – 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of

an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux-] or brazed [ atmosphere-] after \*\*\*\*\* BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 – 8wt% Mn:0.5 – 5wt%. [0011](4) On the surface of a tube which consists of aluminum or an aluminum alloy. Alloy composition Si:6 – 13wt% and Zn:0.5 – 8wt% and Bi:0.1 – 0.5wt%, The remainder carries out thermal spraying of the wax material which consists of an aluminum alloy which consists of aluminum and unescapable non-purity, An aluminum alloy whose alloy composition is Mn:0.5 – 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux-] or brazed [ atmosphere-] after \*\*\*\*\* BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 – 8wt% Mn:0.5 – 5wt%. It is considered as a gist.

[0012]In this invention, what is used as a tube material is not limited to these, although an aluminum alloy which added aluminum or Mn of JIS A1050 and JIS A1100 grade, etc. is mentioned. A tube is fabricated by an extrusion-molding method in aluminum or an aluminum alloy.

[0013]After this invention carries out thermal spraying of the Zn to the surface of a tube of extruded raise in basic wages material with a manufacturing method of a tube material, It is divided when carrying out thermal spraying of the wax material of an aluminum-Si-Zn-Bi alloy to a case where thermal spraying of the wax material of an aluminum-Si-Bi alloy is carried out, at once on the surface of a tube of (Claim 1, 3), and extruded raise in basic wages material (Claim 2, 4).

[0014]In order to carry out thermal spraying of the Zn to a tube, what is necessary is just to carry out thermal spraying immediately after extrusion of an extrusion flat tube of aluminum or an aluminum alloy, and preheating as thermal-spraying pretreatment is unnecessary. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient as a thermal spraying method. Thermal spraying of Zn adjusts the amount of thermal spraying so that metsuke amount may become 5 – 20 g/m<sup>2</sup>.

[0015]Since raise in basic wages material to which the clad of the wax material (hard aluminum-Si alloy) is not carried out is used for a fin material, wax material is made to cover with a spraying process on a tube in this invention. Wax material by which thermal spraying is carried out to the surface of a tube of aluminum or an aluminum alloy is an aluminum-Si-Bi alloy or an aluminum-Si-Bi-Zn alloy of a range specific as mentioned above, and an operation of each ingredient and the Reason for limitation of

a blending ratio are as follows.

[0016]– Lower the melting point of SiAl, make mobility after melting good, and raise brazing nature. If it separates from 6wt% – 13wt% of a range, the melting point of aluminum–Si alloy will become high, and mobility after melting falls and brazing nature falls.

[0017]– Since the wettability of aluminum–Si alloy after Bi melting improves and the mobility of aluminum–Si–alloy wax material improves, brazing nature becomes good. 0. Since the wettability of wax material which consists of an aluminum–Si–alloy thermal spraying material, and mobility fall, it is not desirable less than [ 1wt% ]. Even if it adds exceeding 0.5wt%, the mobility of wax material and wettability which consist of an aluminum–Si–alloy thermal spraying material do not improve.

[0018]– Into Zn brazing heat cycle, it is spread on a surface of heat exchanger tubes, and form a zinc diffused layer very effective in pitting prevention of an aluminum alloy. 0. Since an excessive zinc diffused layer will be formed if a zinc diffused layer effective in corrosion prevention is not formed enough but adds exceeding 8wt%, and an anticorrosion life of a heat exchanger falls on the contrary, it is not desirable less than [ 5wt% ].

[0019]As a thermal spraying method of wax material to a tube (extrusion flattened tube), Although there is a two–way–type method which carries out thermal spraying of the Bi alloy to a tube extruded in pure Zn with a method of carrying out thermal spraying of the Bi alloy aluminum–8 to 13%Si–0.1 to 0.5% further after thermal spraying once to a tube extruded from an extrusion machine aluminum–8 to 13%Si–0.5 to 8%Zn–0.1 to 0.5%, All are effective.

[0020]Methods of carrying out thermal spraying of the wax material to BEAFIN may include a method of carrying out thermal spraying of the above–mentioned after alloy powder, and a method of carrying out thermal spraying of the wire of the above–mentioned alloy, and any may be sufficient. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient.

[0021]A fin used for this invention is the raise in basic wages material (nakedness material to which the clad of the wax material is not carried out) of aluminum–Mn alloy or an aluminum–Mn–Zn alloy. An operation of an ingredient of an aluminum alloy of BEAFIN and the Reason for limitation of a blending ratio are as follows.

[0022]– Mn hardness and intensity improve and modification of a fin at the time of brazing heating can be prevented. 0. Since intensity will go up too much and a fabricating operation of a fin will become difficult if modification of a fin at the time of brazing heating cannot be prevented but it adds exceeding 5wt%, it is not desirable



less than [ 5wt% ].

[0023]– Corrosion potential of Zn fin is lowered and there is an operation which carries out cathodic protection of the tube. 0. In order to carry out cathodic protection of the tube, even if it cannot be considered as potential of sufficient \*\* but adds exceeding 8wt%, potential of \*\* does not improve, but self-corrosion of a fin becomes intense, and it is not desirable less than [ 5wt% ].

[0024]Since wax material is raise in basic wages material by which a clad is not carried out, a fin of this invention is soft, and a life of a cold rolling roll of a manufacturing process of a brazing sheet used as a fin material is extended substantially, and. Since a life of a louver cutter used for louver shearing of a brazing sheet used as a fin material is extended substantially, a manufacturing cost can be lowered substantially.

[0025]BEAFIN with a thickness of 0.1–0.3 mm manufactured by cold rolling etc., A tube material and BEAFIN by which it was fabricated by fin configuration which has a louver with a louver cutter, and wax material was covered with the above-mentioned spraying process using a jig After [ with a group ], By the flux brazing method or the atmosphere brazing method, between headers is joined to a fin, and between tubes and a tube, and it is completed as an aluminum alloy made heat exchanger.

[0026]Flux used by flux brazing will not be limited especially if usually used, but fluoride systems, such as chloride systems, such as NaCl and KCl,  $\text{KAlF}_4$ , and  $\text{K}_3\text{AlF}_6$ , are mentioned, for example.

[0027]The atmosphere brazing method in this invention is among inert atmospheres, such as nitrogen gas and argon gas, a range of cooking temperature is 590–610 \*\*, and the furnace pressure should just braze in the range of 0.1 – 760Torr.

[0028]The brazing temperature should just perform the flux brazing method and the atmosphere brazing method at 590–610 \*\*, wax material fuses in response to a brazing thermal excursion, a fillet is formed between a tube, between fins and a tube, and a header, and junction is completed. Chemical conversion and resin coating processing are performed if needed after that.

[0029]When carrying out thermal spraying of the wax material of an aluminum–Si–Bi alloy after carrying out thermal spraying of the Zn to the surface of a tube of extruded raise in basic wages material, into temperature up of a brazing process, Zn sprayed layers fuse, are diffused in a raise in basic wages tube material, and form an effective Zn diffused layer in a tube surface on corrosion prevention. When carrying out thermal spraying of the wax material of an aluminum–Si–Zn–Bi alloy to the surface of a tube of extruded raise in basic wages material at once, Zn in wax material is spread in a raise in basic wages fin material in a temperature rise process, and an effective Zn layer is

formed on corrosion prevention.

[0030]An aluminum alloy made heat exchanger of this invention is applicable to a heat exchanger of the Serpentine type, a parallel flow type, a DORON cup (lamination) type, and other various form.

[0031]Hereafter, although working example explains this invention in detail, it is not limited to these working example.

[Translation done.]

## EXAMPLE

[Example]

In the 200–400 °C tube (extrusion flattened tube) just behind the extrusion of working example 1 pure aluminium (aluminum:99.9wt%). 10 g/m<sup>2</sup> thermal spraying carried out the pure Zn wire (1.6mmφ) with the arc spraying method, and metals amount 50 g/m<sup>2</sup> thermal spraying carried out the aluminum containing alloy wire which consists of aluminum–11%Si–0.3%Bi immediately after [ the ] with the arc spraying method.

[0033]Louver processing was carried out and the BEAFIN (aluminum–1%Mn–1%Zn) raw material created separately was attached with an above-mentioned tube and jig. After spray coating, it dried and the flux which becomes the attached heat exchanger material from the potash salt of aluminum fluoride was inserted in the NOKOROKKU brazing furnace.

[0034]From ordinary temperature to 605 °C, temperature up of the brazing temperature pattern was carried out, and it was cooled after maintenance for 5 minutes. Into the temperature up of this brazing process, Zn sprayed layers fused, were diffused in the tube material (A1050), and formed the with the surface zinc concentration of 3%, and a diffusing depth of 120 micrometers zinc diffused layer. Compared with the tube core material (pure aluminum of A1050etc), the corrosion potential of this zinc diffused layer was °C, and breakthrough foods were not generated at all in 5000 h of neutral salt spray tests at a 0.4–mm thick tube material, but it was very effective in pitting prevention of a tube.

[0035]Melting was started at 590 °C, it is the brazing retention time for 605 °C x 5 minutes, the fillet of sufficient size was formed on intensity between tube fins and between tube headers, and the wax piece of the brazing part did not generate wax material (aluminum–Si–Bi in a thermal spraying material), either.

[0036]Electric arc spraying of the pure Zn wire (1.6mmφ) was carried out to the 200–400 °C tube just behind the extrusion of working example 2 pure aluminium (aluminum:99.9wt%), and thermal spraying of the powder (particle size undershirt of 70 micrometers) of a Bi alloy was further carried out to it by high speed gas flame thermal spraying aluminum–11%Si–0.3% after that.

[0037]The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4–mm thick tube material.

[0038]Thermal spraying of the aluminum alloy wire (1.6mmφ) which becomes a 200–400 °C tube just behind the extrusion of working example 3 pure aluminium

(aluminum:99.9wt%) from aluminum-11%Si-5%Zn-0.3%Bi was carried out by electric arc spraying.

[0039]The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0040]Thermal spraying of (the particle size undershirt of 70 micrometers) was carried out for the aluminum alloy powder which becomes a 200-400 \*\* tube just behind the extrusion of working example 4 pure aluminium (aluminum:99.9wt%) from a Bi alloy aluminum-11%Si-5%Zn-0.3% by high speed gas flame thermal spraying.

[0041]The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0042]Once having dried and preheating the tube material made from working example 5 aluminum alloy (extrusion flattened tube) with an arc and gas flame at 200-400 \*\* after water cooling, even if it performed above-mentioned working example 1-4, it checked that the completely same result was obtained.

[0043]The interval of regrinding by paper polish of a roll in the cold rolling process of each working example was extended several times, and it was admitted that the endurance of a roll was improving.

[0044]It was admitted that the endurance (hour of use until it discards) of the louver cutter in each working example was also extended several times.

[Translation done.]

## WRITTEN AMENDMENT

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[A Written

Amendment]

[Filing date]Heisei 6(1994) June 20

[Amendment 1]

[Document to be Amended]Description

[Item(s) to be Amended]0002

[Method of Amendment]Change

[Proposed Amendment]

[0002]

[Description of the Prior Art]The conventional aluminum alloy made heat exchanger to the tube material which consists of raise in basic wages material of aluminum (JISA1050, JIS A1100) or an aluminum alloy (aluminum-Mn) by which extrusion molding was carried out. Make aluminum-Mn alloy into a core material, use Si for wax material aluminum-6 to 15%, and both are cold-rolled between heat from a clad sheet, It was considered as the brazing sheet, the fabrication of the fin material which consists of a tube which carried out Zn thermal spraying, and a brazing sheet was carried out, and the back with a group had joined between headers to the tube of an aluminum alloy, and between fins and a tube by the flux brazing method or atmosphere brazing with the jig.

[Amendment 2]

[Document to be Amended]Description

[Item(s) to be Amended]0003

[Method of Amendment]Change

[Proposed Amendment]

[0003]However, since a fin is the brazing sheet in which the clad of high aluminum-Si alloy or the aluminum-Si-Zn alloy of hardness was carried out to the surface in this conventional method, In the rolling process, especially cold rolling process from an ingot clad sheet of a brazing sheet, wear of a reduction roll is intense, and. When processing a brazing sheet into the fin of a heat exchanger, the abrasion life of the louver cutter which carries out shearing of the louver formed in a fin is dramatically short, and the manufacturing cost of an aluminum alloy made heat exchanger becomes high.

[Amendment 3]

[Document to be Amended]Description

[Item(s) to be Amended]0020

[Method of Amendment]Change

[Proposed Amendment]

[0020]Methods of carrying out thermal spraying of the wax material to BEACHUBU may include the method of carrying out thermal spraying of the above-mentioned after alloy powder, and the method of carrying out thermal spraying of the wire of the above-mentioned alloy, and any may be sufficient. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient.

[Amendment 4]

[Document to be Amended]Description

[Item(s) to be Amended]0025

[Method of Amendment]Change

[Proposed Amendment]

[0025]BEAFIN with a thickness of 0.05–0.3 mm manufactured by cold rolling etc., The tube material and BEAFIN by which it was fabricated by the fin configuration which has a louver with a louver cutter, and wax material was covered with the above-mentioned spraying process using a jig After [ with a group ], By the flux brazing method or the atmosphere brazing method, between headers is joined to a fin, and between tubes and a tube, and it is completed as an aluminum alloy made heat exchanger.

[Amendment 5]

[Document to be Amended]Description

[Item(s) to be Amended]0029

[Method of Amendment]Change

[Proposed Amendment]

[0029]When carrying out thermal spraying of the wax material of an aluminum–Si–Bi alloy after carrying out thermal spraying of the Zn to the surface of the tube of the extruded raise in basic wages material, into the temperature up of a brazing process, Zn sprayed layers fuse, are diffused in a raise in basic wages tube material, and form an effective Zn diffused layer in a tube surface on corrosion prevention. When carrying out thermal spraying of the wax material of an aluminum–Si–Zn–Bi alloy to the surface of the tube of the extruded raise in basic wages material at once, Zn in wax material is spread in a raise in basic wages fin material in a temperature rise process, and an effective Zn diffused layer is formed on corrosion prevention.

[Amendment 6]

[Document to be Amended]Description

[Item(s) to be Amended]0047

[Method of Amendment]Change

[Proposed Amendment]

[0047](3) Since a fin is the soft raise in basic wages material of aluminum-Mn alloy or an aluminum-Mn-Zn alloy, wear of the reduction roll of the rolling process from an ingot, especially a cold rolling process is \*\*\*\*(ed) sharply, and an endurance life improves sharply, and. The endurance of the louver cutter at the time of louver processing of the heat-exchanger-fins material (0.05-0.3-mm thickness) which consists of brazing sheets can improve preeminently, and a manufacturing cost can be reduced.

[Translation done.]

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(54) 【発明の名称】 アルミニウム合金製熱交換器およびその製造方法

(57) 【要約】

【目的】 製造コストが低減され、チューブ材とフィン  
の接合強度と耐食性に優れたアルミニウム合金製熱交換  
器を提供する。

【構成】 表面に Zn を溶射した後、ろう材を溶射した  
皮膜を有するアルミニウムまたはアルミニウム合金から  
なるチューブ材に、アルミニウム合金からなるペアフィ  
ンを、フラックスろう付または雰囲気ろう付により接合  
したアルミニウム合金製熱交換器であって、ろう材の合  
金組成が、Si : 6 ~ 13 wt %、Bi : 0.1 ~ 0.  
5 wt %、残部が Al および不可避免の不純分からなるア  
ルミニウム合金であり、ペアフィンのアルミニウム合金  
組成が、Mn : 0.5 ~ 5 wt %、残部が Al および不  
可避的不純分からなるアルミニウム合金または Mn :  
0.5 ~ 5 wt %、Zn : 0.5 ~ 8 wt %、残部が Al  
および不可避免の不純分からなるアルミニウム合金であ  
ることを特徴とするアルミニウム合金製熱交換器。



## 【特許請求の範囲】

【請求項1】 表面にZnを溶射した後、ろう材を溶射した皮膜を有するアルミニウムまたはアルミニウム合金からなるチューブ材に、アルミニウム合金からなるペアフィンを、フラックスろう付または雰囲気ろう付により接合したアルミニウム合金製熱交換器であって、ろう材の合金組成が、Si:6~13wt%、Bi:0.1~0.5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金であり、ペアフィンのアルミニウム合金組成が、Mn:0.5~5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金、またはMn:0.5~5wt%、Zn:0.5~8wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金であることを特徴とするアルミニウム合金製熱交換器。

【請求項2】 表面にろう材を溶射した皮膜を有するアルミニウムまたはアルミニウム合金からなるチューブ材に、アルミニウム合金からなるペアフィンを、フラックスろう付または雰囲気ろう付により接合したアルミニウム合金製熱交換器であって、ろう材の合金組成が、Si:6~13wt%、Zn:0.5~8wt%、Bi:0.1~0.5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金であり、ペアフィンのアルミニウム合金組成が、Mn:0.5~5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金、またはMn:0.5~5wt%、Zn:0.5~8wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金であることを特徴とするアルミニウム合金製熱交換器。

【請求項3】 アルミニウムまたはアルミニウム合金からなるチューブの表面にZnを溶射した後、合金組成がSi:6~13wt%、Bi:0.1~0.5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金からなるろう材を溶射し、合金組成が、Mn:0.5~5wt%、残部がAlおよび不可避的不純分であるアルミニウム合金、またはMn:0.5~5wt%、Zn:0.5~8wt%、残部がAlおよび不可避的不純分であるアルミニウム合金からなるペアフィンを、組付た後、フラックスろう付または雰囲気ろう付して接合したことを特徴とするアルミニウム合金製熱交換器の製造方法。

【請求項4】 アルミニウムまたはアルミニウム合金からなるチューブの表面に、合金組成がSi:6~13wt%、Zn:0.5~8wt%、Bi:0.1~0.5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金からなるろう材を溶射し、合金組成が、Mn:0.5~5wt%、残部がAlおよび不可避的不純分であるアルミニウム合金、またはMn:0.5~5wt%、Zn:0.5~8wt%、残部がAlおよび不可避的不純分であるアルミニウム合金からなるペアフィンを、組付た後、フラックスろう付または雰囲気ろう付し

て接合したことを特徴とするアルミニウム合金製熱交換器の製造方法。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】本発明は、フラックスろう付法または雰囲気ろう付により製造されるアルミニウム合金製熱交換器に関する物であり、本発明のアルミニウム合金製熱交換器は、カークーラー用熱交換器、産業用熱交換器などに広く適用されるものである。

## 【0002】

【従来の技術】従来のアルミニウム合金製熱交換器は、押出成形されたアルミニウム(JIS A1050、JIS A1100)またはアルミニウム合金(Al-Mn)のペア材からなるチューブ材に、Al-Mn合金を芯材とし、ろう材にAl-6~15%Si-0.5~3%Mg合金またはAl-7~15%Si合金を用い、両者を合せ板から熱間、冷間圧延して、ブレイジングシートとし、Zn溶射したチューブとブレイジングシートからなるフィン材を切組し治具にて組付後、フラックスろう付法または雰囲気ろう付によりアルミニウム合金のチューブとフィン間、チューブとヘッダ間を接合していた。

【0003】しかし、この従来法ではフィンは硬度の高いAl-Si-Mg合金またはAl-Si-Mg-Zn合金が表面にクラッドされたブレイジングシートであるため、ブレイジングシートのインゴット合せ板からの圧延過程、特に冷間圧延過程において圧延ロールの摩耗が激しいと共に、ブレイジングシートを熱交換器のフィンに加工する際、フィンに形成されるルーバを剪断加工するルーバカッタの摩耗寿命が非常に短く、アルミニウム合金製熱交換器の製造コストが高くなる。

【0004】また、アルミニウムまたはアルミニウム合金のチューブの表面に特定範囲のAl-Zn-Si合金の皮膜を形成し、ろう材を有しないフィンを組付けて、フラックスろう付するアルミニウム製熱交換器の製造方法が知られている(特開平1-107961号)。

【0005】しかしながら、この従来技術では、ろう材のぬれ性、流動性が充分でないため、接合の強度がやや不足するという問題点があった。

## 【0006】

【発明が解決しようとする課題】本発明は、上記従来技術の問題点を解消すべくなされたものであり、本発明の目的は、ブレイジングシートのインゴット合せ板からの圧延過程における圧延ロールの寿命を伸ばし、フィンに形成されるルーバを剪断加工するルーバカッタの摩耗寿命を伸ばすことによりアルミニウム合金製熱交換器の製造コストを低減し、チューブ材とフィンの接合強度と耐食性に優れたアルミニウム合金製熱交換器を提供することである。

## 【0007】

【課題を解決するための手段および作用】本発明者らは、上記課題を解決すべく鋭意研究を重ねた結果、ろう材としてチューブ材表面にBiを含む特定の合金を溶射し、特定のアルミニウム合金のベア材からなるフィンを組付後、フラックスろう付または雰囲気ろう付すればよいことを見いだし本発明を完成するに至った。

【0008】すなわち本発明は、

(1) 表面にZnを溶射した後、ろう材を溶射した皮膜を有するアルミニウムまたはアルミニウム合金からなるチューブ材に、アルミニウム合金からなるベアフィンを、フラックスろう付または雰囲気ろう付により接合したアルミニウム合金製熱交換器であって、ろう材の合金組成が、Si:6~13wt%、Bi:0.1~0.5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金であり、ベアフィンのアルミニウム合金組成が、Mn:0.5~5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金、またはMn:0.5~5wt%、Zn:0.5~8wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金であることを特徴とするアルミニウム合金製熱交換器。

【0009】(2) 表面にろう材を溶射した皮膜を有するアルミニウムまたはアルミニウム合金からなるチューブ材に、アルミニウム合金からなるベアフィンを、フラックスろう付または雰囲気ろう付により接合したアルミニウム合金製熱交換器であって、ろう材の合金組成が、Si:6~13wt%、Zn:0.5~8wt%、Bi:0.1~0.5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金であり、ベアフィンのアルミニウム合金組成が、Mn:0.5~5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金、またはMn:0.5~5wt%、Zn:0.5~8wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金であることを特徴とするアルミニウム合金製熱交換器。

【0010】(3) アルミニウムまたはアルミニウム合金からなるチューブの表面にZnを溶射した後、合金組成がSi:6~13wt%、Bi:0.1~0.5wt%、残部がAlおよび不可避的不純分からなるアルミニウム合金からなるろう材を溶射し、合金組成が、Mn:0.5~5wt%、残部がAlおよび不可避的不純分であるアルミニウム合金、またはMn:0.5~5wt%、Zn:0.5~8wt%、残部がAlおよび不可避的不純分であるアルミニウム合金からなるベアフィンを、組付た後、フラックスろう付または雰囲気ろう付して接合したことを特徴とするアルミニウム合金製熱交換器の製造方法。

【0011】(4) アルミニウムまたはアルミニウム合金からなるチューブの表面に、合金組成がSi:6~13wt%、Zn:0.5~8wt%、Bi:0.1~0.5wt%、残部がAlおよび不可避的不純分からな

るアルミニウム合金からなるろう材を溶射し、合金組成が、Mn:0.5~5wt%、残部がAlおよび不可避的不純分であるアルミニウム合金、またはMn:0.5~5wt%、Zn:0.5~8wt%、残部がAlおよび不可避的不純分であるアルミニウム合金からなるベアフィンを、組付た後、フラックスろう付または雰囲気ろう付して接合したことを特徴とするアルミニウム合金製熱交換器の製造方法。を要旨とするものである。

【0012】本発明において、チューブ材として用いられるものは、JIS A1050、JIS A1100等のアルミニウムまたはMn等を添加したアルミニウム合金が挙げられるが、これらに限定されるものではない。チューブは、アルミニウムまたはアルミニウム合金を、押出し成形法により成形される。

【0013】本発明は、チューブ材の製造方法により、押出されたベア材のチューブの表面にZnを溶射した後、Al-Si-Bi合金のろう材を溶射する場合と(請求項1、3)、押出されたベア材のチューブの表面にAl-Si-Zn-Bi合金のろう材を1回で溶射する場合(請求項2、4)とに分けられる。

【0014】チューブへ、Znを溶射するには、アルミニウムまたはアルミニウム合金の押出し扁平管の押出し直後に溶射すればよく、溶射前処理としての予熱は不要である。溶射方法は、フレーム溶射、高速ガス炎溶射、アーク溶射のいずれでもよい。Znの溶射は、目付量が5~20g/m<sup>2</sup>となるように溶射量を調整する。

【0015】本発明において、フィン材は、ろう材(硬いAl-Si合金)がクラッドされていないベア材を用いるため、ろう材はチューブ上に溶射法によって被覆させる。アルミニウムまたはアルミニウム合金のチューブの表面に溶射されるろう材は、上記のように特定の範囲の、Al-Si-Bi合金またはAl-Si-Bi-Zn合金であり、各成分の作用と配合割合の限定理由は、以下のとおりである。

【0016】・Si

Alの融点を下げ、溶融後の流動性を良好にし、ろう付性を向上させる。6wt%~13wt%の範囲を外れると、Al-Si合金の融点が高くなると共に、溶融後の流動性が低下し、ろう付性が低下する。

【0017】・Bi

溶融後のAl-Si合金のぬれ性が向上し、Al-Si合金ろう材の流動性が向上するため、ろう付性がよくなる。0.1wt%未満では、Al-Si合金溶射材からなるろう材のぬれ性、流動性が低下するため好ましくない。また、0.5wt%を超えて添加しても、Al-Si合金溶射材からなるろう材の流動性およびぬれ性は向上しない。

【0018】・Zn

ろう付加熱サイクル中に、熱交換器チューブの表層に拡散し、アルミニウム合金の孔食防止に極めて有効な亜鉛

拡散層を形成する。0.5wt%未満では、防食に有効な亜鉛拡散層が充分形成されず、8wt%を超えて添加すると、過大な亜鉛拡散層が形成されるため、かえって熱交換器の耐食寿命が低下するため好ましくない。

【0019】チューブ（押出偏平管）へのろう材の溶射方法としては、押出機から押出されたチューブへ純Znを溶射後、さらにAl-8~13%Si-0.1~0.5%B合金を溶射する方法と、押出されたチューブにAl-8~13%Si-0.5~8%Zn-0.1~0.5%B合金を1回のみ溶射する二方法があるが、

いずれも有効である。

【0020】ベアフィンにろう材を溶射する方法としては、上記合金粉末を溶射する方法、上記合金のワイヤを溶射する方法があり、いずれでもよい。また、フレーム溶射、高速ガス炎溶射、アーク溶射のいずれでもよい。

【0021】本発明に用いられるフィンは、Al-Mn合金又はAl-Mn-Zn合金のベア材（ろう材がクラッドされていない裸材）である。ベアフィンのアルミニウム合金の成分の作用と配合割合の限定理由は、以下のとおりである。

#### 【0022】・Mn

硬さおよび強度が向上すると共に、ろう付加熱時のフィンの変形を防止できる。0.5wt%未満では、ろう付加熱時のフィンの変形が防止できず、5wt%を超えて添加すると強度が上りすぎてフィンの成形加工が困難になるため好ましくない。

#### 【0023】・Zn

フィンの腐食電位を下げ、チューブを陰極防食する作用がある。0.5wt%未満では、チューブを陰極防食するために充分な卑の電位とすることができず、8wt%を超えて添加しても、卑の電位が向上せず、フィンの自己腐食が激しくなり好ましくない。

【0024】本発明の、フィンはろう材がクラッドされていないベア材であるため軟らかく、フィン材となるブレージングシートの製造工程の冷間圧延ロールの寿命が大幅に伸びると共に、フィン材となったブレージングシートのルーバ剪断加工に用いるルーバカッタの寿命が大幅に伸びるため、製造コストを大幅に下げることができる。

【0025】冷間圧延等により製造された厚さ0.1~0.3mmのベアフィンは、ルーバカッタによりルーバを持つフィン形状に成形され、上記の溶射法によりろう材が被覆されたチューブ材とベアフィンとを治具を用いて組付後、フラックスろう付法または雰囲気ろう付法にて、フィンとチューブ間、チューブとヘッダ間が接合されアルミニウム合金製熱交換器として完成される。

【0026】フラックスろう付で使用されるフラックスは、通常用いられるものであれば特に限定されないが、例えばNaCl、KCl等の塩化物系、KAlF<sub>4</sub>、KAlF<sub>6</sub>等のフッ化物系が挙げられる。

【0027】本発明における雰囲気ろう付法は、窒素ガス、アルゴンガスなどの不活性雰囲気中、加熱温度は590~610℃の範囲で、炉内圧力は0.1~760 Torrの範囲でろう付を行えばよい。

【0028】フラックスろう付法および雰囲気ろう付法ともに、ろう付温度は590~610℃で行えばよく、ろう付熱サイクルを受けてろう材が溶融して、チューブとフィン間、チューブとヘッダ間にフィレットが形成され接合が完了する。その後必要に応じて化成処理、樹脂被覆処理が施される。

【0029】押出されたベア材のチューブの表面にZnを溶射した後、Al-Si-B合金のろう材を溶射する場合は、ろう付過程の昇温中にZn溶射層は溶融し、ベアチューブ材中に拡散して、チューブ表面に防食上有効なZn拡散層を形成する。押出されたベア材のチューブの表面にAl-Si-Zn-B合金のろう材を1回で溶射する場合は、昇温過程でろう材中のZnがベアフィン材中に拡散し、防食上有効なZn層を形成する。

【0030】なお、本発明のアルミニウム合金製熱交換器は、サーペントイン型、パラレルフロー型、ドロムカップ（積層）型、その他各種型式の熱交換器に適用することができる。

【0031】以下、実施例により本発明を詳細に説明するが、これらの実施例に限定されるものではない。

#### 【0032】

##### 【実施例】

##### 実施例1

純アルミニウム（Al:99.9wt%）の押出直後の200~400℃のチューブ（押出偏平管）に、純Znワイヤ（1.6mmφ）をアーク溶射法により10g/m<sup>2</sup>溶射し、その直後Al-11%Si-0.3%Bからなるアルミ合金ワイヤをアーク溶射法により目付量50g/m<sup>2</sup>溶射した。

【0033】別途作成されたベアフィン（Al-1%Mn-1%Zn）素材はルーバ加工され、上記のチューブと治具にて組付けた。組付けた熱交換器素材にフッ化アルミニウムのカリ塩からなるフラックスをスプレー塗布後、乾燥し、ノコックろう付炉に挿入した。

【0034】ろう付温度パターンは、常温から605℃まで昇温し5分間保持後冷却した。このろう付過程の昇温中にZn溶射層は溶融し、チューブ材（Al050）中に拡散し表面亜鉛濃度3%、拡散深さ120μmの亜鉛拡散層を形成した。この亜鉛拡散層はチューブ芯材（Al050etcの純アルミ）に比べ腐食電位が卑であり、塩水噴霧試験5000hにて0.4mmの肉厚のチューブ材に貫通孔食は全く発生せず、チューブの孔食防止に極めて有効であった。

【0035】また、ろう材（溶射材中のAl-Si-B）は590℃で溶融を開始し、605℃×5分のろう付保持時間で、チューブ-フィン間、チューブ-ヘッダ

間に強度上十分な大きさのフィレットが形成され、ろう付部のろう切れも発生しなかった。

#### 【0036】実施例2

純アルミニウム（Al：99.9wt%）の押出直後の200～400℃のチューブに、純Znワイヤ（1.6mmφ）をアーク溶射し、さらにその後Al-11%Si-0.3%B i合金の粉末（粒度70μmアンダー）を高速ガス炎溶射により溶射した。

【0037】その後の工程は実施例1に準じ、アルミニウム合金製熱交換器を製造した。5000h塩水噴霧試験を行っても、0.4mmの肉厚のチューブ材に貫通孔食は全く発生しなかった。

#### 【0038】実施例3

純アルミニウム（Al：99.9wt%）の押出直後の200～400℃のチューブに、Al-11%Si-5%Zn-0.3%B iからなるAl合金ワイヤ（1.6mmφ）をアーク溶射により溶射した。

【0039】その後の工程は実施例1に準じ、アルミニウム合金製熱交換器を製造した。5000h塩水噴霧試験を行っても、0.4mmの肉厚のチューブ材に貫通孔食は全く発生しなかった。

#### 【0040】実施例4

純アルミニウム（Al：99.9wt%）の押出直後の200～400℃のチューブに、Al-11%Si-5%Zn-0.3%B i合金からなるアルミニウム合金粉末を（粒度70μmアンダー）を高速ガス炎溶射で溶射した。

【0041】その後の工程は実施例1に準じ、アルミニウム合金製熱交換器を製造した。5000h塩水噴霧試験を行っても、0.4mmの肉厚のチューブ材に貫通孔食は全く発生しなかった。

#### 【0042】実施例5

\*

\*アルミニウム合金製のチューブ材（押出偏平管）を一旦水冷後、乾燥し、200～400℃で、アーク、ガス炎にて予熱した後、上記実施例1～4を行っても全く同じ結果が得られることを確認した。

【0043】各実施例の冷間圧延工程における、ロールのペーパー研磨による再研磨の間隔が数倍に伸び、ロールの耐久性が向上していることが認められた。

【0044】また、各実施例におけるルーバカッタの耐久性（廃棄するまでの使用時間）も数倍に伸びたことが認められた。

#### 【0045】

【発明の効果】本発明のアルミニウム合金製熱交換器は、以下のような優れた効果を有する。

（1）チューブ材の表面に溶射されるろう材にB iが含まれているため、ろう材の流動性、ぬれ性が改善されるため、チューブフィン間、チューブヘッド間に充分なフィレットが形成され、強度、耐圧上充分な接合がなされる。

【0046】（2）ベアフィンに溶射されたZnまたはろう材中のZnは、フラックスろう付または雰囲気ろう付過程における熱サイクルによりチューブ材中に拡散し、チューブの耐食性向上に抜群の効果のあるZn拡散層を形成する。

【0047】（3）フィンがAl-Mn合金またはAl-Mn-Zn合金の軟らかなベア材であるため、インゴットからの圧延過程特に冷間圧延過程の圧延ロールの摩耗が大巾に制限され耐久寿命が大巾に向上すると共に、ブレイジングシートからなる熱交換器フィン材（0.1～0.3mm厚）のルーバ加工時のルーバカッタの耐久性が抜群に向上し、製造コストを低減することができる。

#### 【手続補正書】

【提出日】平成6年6月20日

【手続補正1】

【補正対象書類名】明細書

【補正対象項目名】0002

【補正方法】変更

【補正内容】

【0002】

【従来の技術】従来のアルミニウム合金製熱交換器は、押出成形されたアルミニウム（JISA1050、JISA1100）またはアルミニウム合金（Al-Mn）のベア材からなるチューブ材に、Al-Mn合金を芯材とし、ろう材にAl-6～15%Siを用い、両者を合せ板から熱間、冷間圧延して、ブレイジングシートとし、Zn溶射したチューブとブレイジングシートからなるフィン材を組組し治具にて組付後、フラックスろう

付法または雰囲気ろう付によりアルミニウム合金のチューブとフィン間、チューブとヘッド間を接合していた。

【手続補正2】

【補正対象書類名】明細書

【補正対象項目名】0003

【補正方法】変更

【補正内容】

【0003】しかし、この従来法ではフィンは硬度の高いAl-Si合金またはAl-Si-Zn合金が表面にクラッドされたブレイジングシートであるため、ブレイジングシートのインゴット合せ板からの圧延過程、特に冷間圧延過程において圧延ロールの摩耗が激しいと共に、ブレイジングシートを熱交換器のフィンに加工する際、フィンに形成されるルーバを剪断加工するルーバカッタの摩耗寿命が非常に短く、アルミニウム合金製熱交

換器の製造コストが高くなる。

【手続補正3】

【補正対象書類名】明細書

【補正対象項目名】0020

【補正方法】変更

【補正内容】

【0020】ベアチューブにろう材を溶射する方法としては、上記合金粉末を溶射する方法、上記合金のワイヤを溶射する方法があり、いずれでもよい。また、フレーム溶射、高速ガス炎溶射、アーク溶射のいずれでもよい。

【手続補正4】

【補正対象書類名】明細書

【補正対象項目名】0025

【補正方法】変更

【補正内容】

【0025】冷間圧延等により製造された厚さ0.05～0.3mmのベアフィン、ルーバカッタによりルーバを持つフィン形状に成形され、上記の溶射法によりろう材が被覆されたチューブ材とベアフィンとを治具を用いて組付後、フラックスろう付法または雰囲気ろう付法にて、フィンとチューブ間、チューブとヘッダ間が接合されアルミニウム合金製熱交換器として完成される。

【手続補正5】

【補正対象書類名】明細書

\*

\*【補正対象項目名】0029

【補正方法】変更

【補正内容】

【0029】押出されたベア材のチューブの表面にZnを溶射した後、Al-Si-Bi合金のろう材を溶射する場合は、ろう付過程の昇温中にZn溶射層は溶融し、ベアチューブ材中に拡散して、チューブ表面に防食上有効なZn拡散層を形成する。押出されたベア材のチューブの表面にAl-Si-Zn-Bi合金のろう材を1回で溶射する場合は、昇温過程でろう材中のZnがベアフィン材中に拡散し、防食上有効なZn拡散層を形成する。

【手続補正6】

【補正対象書類名】明細書

【補正対象項目名】0047

【補正方法】変更

【補正内容】

【0047】(3)フィンがAl-Mn合金またはAl-Mn-Zn合金の軟らかなベア材であるため、インゴットからの圧延過程特に冷間圧延過程の圧延ロールの摩耗が大巾に制限され耐久寿命が大巾に向上すると共に、ブレードシートからなる熱交換器フィン材(0.05～0.3mm厚)のルーバ加工時のルーバカッタの耐久性が抜群に向上し、製造コストを低減することができる。

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